

# 内蒙古巴音满都呼晚白垩世棱齿龙 蛋化石的发现

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**关键词** 内蒙古巴音满都呼 晚白垩世 棱齿龙蛋

## 内 容 提 要

本文记述的恐龙蛋化石标本,采自内蒙古乌拉特后旗巴音满都呼上白垩统牙道黑达组中。蛋化石在蛋窝中排列的方式和蛋壳的显微结构特征与北美发现的含有可鉴定为棱齿龙胚胎骨骼的蛋化石基本相似,但还有一些差别,如蛋壳外表面不具纵向细纹,柱状层中鱼骨型纹饰不明显等。因此,应为棱齿龙科中另一新的属种代表。

内蒙古乌拉特后旗巴音满都呼是近年来颇受关注的晚白垩世恐龙化石产地之一。本世纪30年代,中一瑞考察团布林等人曾到巴音满都呼一带考察,但未见有发现恐龙或蛋化石的报道。70年代后期,本文作者之一(李荣)曾先后三次到这一地区进行调查,采集到原角龙、恐龙蛋壳及其它的一些爬行类化石。1987—1988年,中一加恐龙考察团曾在这一地区进行考察,发现了大量的恐龙,特别是甲龙类和原角龙化石,成窝的恐龙蛋及其它的脊椎动物化石,从而引起中外有关学者的注目。1990年秋季,本文作者之一在巴音满都呼公路口南侧采集到一窝较为完整的,属于棱齿龙类(Hypsilophodonts)的恐龙蛋;1992年10月,又在公路北侧发现了另一枚完整的蛋化石。

棱齿龙蛋化石最初发现于北美蒙大拿西部(Horner, 1982, 1984, 1987; Horner and Gorman, 1988; Horner and Weishampel, 1988; Hirsch and Quinn, 1990)。由于在这些蛋化石中含有可以被确定为棱齿龙类(*Orodromeus makelai*)的胚胎骨化石,才明确地确立了这类恐龙的蛋壳结构型态(Horner and Weishampel, 1988; Hirsch and Quinn, 1990)。现在棱齿龙蛋在我国的发现,进一步增加了我们的古蛋类学的知识。在此,本文予描述报道。

## 一、蛋化石记述

### 棱齿龙科 (*Hypsilophodontidae*)

**科鉴别特征** 蛋化石为长形。蛋壳由纤细的、呈棱柱状的基本结构单元组成,锥体层薄,约占蛋壳厚度的  $1/7$ 。

蛋化石为垂直或稍为倾斜地竖立在蛋窝中,蛋的尖端朝下。

### 棱柱形蛋属(新属) (*Prismatoolithus* gen. nov.)

**属鉴别特征** 见代表种戈壁棱柱形蛋

### 戈壁棱柱形蛋(新种) (*Prismatoolithus gebiensis* sp. nov.)

(图版 I—II, 图 1)

**正型标本** 7 枚完整程度不同的蛋化石(编号: NMB4341; 野外编号: No. 9002)。

**副型标本** 1 枚保存相当完整的蛋化石(野外编号: No. 9201)。

**地点和层位** 内蒙古巴彦淖尔盟乌拉特后旗巴音满都呼公路口南侧 150 米; 公路北侧 4 公里。上白垩统牙道黑达组。

**蛋化石描述** 根据现场观察,所有的蛋化石在蛋窝中都是直立或稍为倾斜竖立的排列方式。蛋化石较尖的一端朝下,埋在沉积岩中。蛋的钝端向上。因暴露于地表面,结果所有的蛋化石的钝端都不同程度受到侵蚀破坏。图版 I, 1 表示的是该蛋窝的倒转面观,因此可见蛋的尖端向上。

蛋化石呈长形,其长径和横径之比大约为 2:1。对一个完整的蛋化石(图版 I, 2)的大小作了测量,其长径为 120 毫米,最大横径在距该蛋化石钝端 40—70 毫米处为 50 毫米;最小横径在距该蛋化石尖端 13 毫米处为 40 毫米。

蛋壳很薄,一般在 0.7—0.9 毫米之间。蛋壳呈灰白色,外表面光滑(图版 I, 3),但在低倍放大下,有一些蛋壳外表面则显示出微小凹坑(图版 II, 1),大小一般  $0.1 \times 0.15$  毫米。这种特征可能是蛋壳表面受到不同程度侵蚀的结果。根据我们的观察,在靠近尖端处的蛋壳,未发现有气孔。然而在蛋化石中部处的蛋壳,才见有气孔分布;越靠近蛋的钝端,气孔数量逐渐增多。气孔的这种分布特征表明,因蛋的尖端朝下埋在沙土中,钝端朝上暴露于地表面,气孔主要分布在蛋的钝端有利于胚胎发育时的气体交换。气孔口略呈圆形,直径约 0.05 毫米。蛋壳内表面在低倍放大下,一般可见到锥体基部一乳突,略呈圆形或方形。

在偏光显微镜和扫描电镜下观察蛋壳径切面,可以清楚地看到,它是由纤细的基本结构单元组成。这些壳单元排列紧密,互相联结形成一连续层,基本上显示出典型的似鸟型蛋壳结构(图 1;图版 II, 2, 3)。锥体层很薄,一般约占蛋壳厚度的  $1/7$ 。在偏光显微镜下,锥体中的拱形生长线一般可见。在柱状层中,纤细的柱体也可以明显区别开来。在正交偏光下,锥体消光位明显可见。然而柱状层中方解石微晶的菱面形解理—即所谓的鱼骨型纹饰(Herring-bone pattern)不很明显(图版 II)。

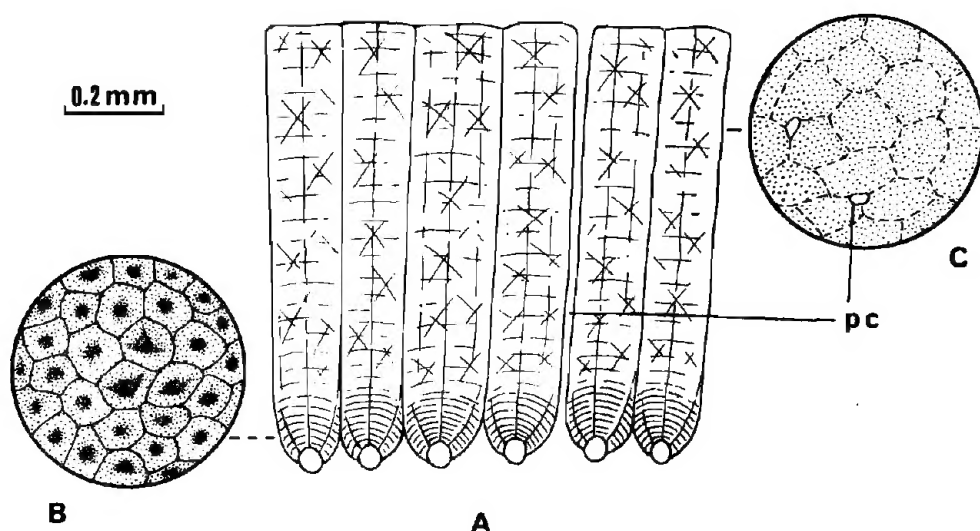


图1 戈壁棱柱形蛋蛋壳显微结构图

A. 径切面; B. 近内表面处弦切面; C. 近外表面处弦切面;

Fig. 1 Diagrammatic representation of eggshell structure of *Prismooolithus gebiensis*

A. radial view; B. tangential section through the cone layer; C. tangential section through the columnar layer near the outer surface of the eggshell.

Symbol: PC = pore canal.

## 二、鉴定与讨论

### 1. 关于戈壁棱柱形蛋在恐龙蛋分类系统中的地位

根据以上的描述,本文研究的内蒙古巴音满都呼出产的蛋化石的形态特征可以归纳如下:蛋化石为长形,长径120毫米,最大横径50毫米。蛋化石以垂直或稍为倾斜的竖立在蛋窝中,蛋的尖端朝下,蛋壳薄,在0.7—0.9毫米之间。气孔主要分布于靠近钝端。蛋壳由纤细的棱柱状的基本结构单元组成。这些特征与北美蒙大拿西部 Teton County 发现的晚白垩世棱齿龙蛋的非常相似。

恐龙蛋是一类稀有的但又是很特殊的化石。一般说来,由于现在还无法知道它们的形态结构和恐龙骨化石之间的关系。因此要指出某一种蛋化石是某一种恐龙的蛋,的确是一个很棘手的问题(赵资奎、蒋元凯,1974)。最近,Horner 和 Weishampel (1988)在蒙大拿西部 Teton County 采集到的一窝有19个蛋化石中,发现保存有可鉴定为棱齿龙类 *Orodromeus makelai* 的胚胎骨骼化石。在这一基础上,Hirsch 和 Quinn (1990)对这些蛋壳进行观察,确立了含棱齿龙骨化石的蛋壳结构形态特征,从而为解决这类蛋化石的归属问题提供了直接证据。

上面描述清楚地表明,在巴音满都呼发现的这些蛋化石应属棱齿龙科。根据 Hirsch 和 Quinn (1990)的观察,*Orodromeus makelai* 的蛋壳外表面具有纵向的细纹;气孔口一般位于蛋壳外表面的长形凹陷中,这些特征在巴音满都呼的标本中并未见到。此外,

北美的 *Orodromeus makelai* 蛋壳柱状层中的鱼骨型纹饰非常明显,而在巴音满都呼蛋壳的柱状层中,这一结构特征则很不发育。所有这些表明,巴音满都呼蛋壳的结构特征和北美 *Orodromeus makelai* 的仍有一些明显的差别。考虑到这些棱齿龙类蛋化石是分布在北美及亚洲这样两块相距如此遥远而又不直接相连的大陆上,因此有理由把本文记述的巴音满都呼蛋化石同北美 *Orodromeus makelai* 的区别开来,作为棱齿龙科中一新的属种的代表。遗憾地是在巴音满都呼发现的这些蛋化石中,并未发现任何胚胎骨化石。根据赵资奎(1975,1979,1992)提出的恐龙蛋分类系统及其分类原则,我们认为:由于其蛋壳的基本结构单元呈棱柱状,故命名为戈壁棱柱形蛋 (*Prismatoolithus gebiensis* gen. et sp. nov.)。种名表示蛋化石出产于戈壁滩中。

最近, Mikhailov (1991) 报告,在北美科罗拉多的上侏罗统莫利逊组 (Morrison Formation) 出产的蛋壳化石是属于棱齿龙的;现在完整的棱齿龙蛋化石在巴音满都呼发现为正确鉴定我国其它地区发现的属于这类恐龙的破碎蛋壳提供了可靠的科学依据。根据本文作者之一(赵资奎)的观察,这种蛋也发现于广东省南雄盆地的上白垩统南雄群中,从而为了解棱齿龙蛋的地理分布和地层分布提供了新的资料。详细分析,将在另文报告。

## 2. 关于戈壁棱柱形蛋的年代问题

戈壁棱柱形蛋发现于内蒙古巴彦淖尔盟乌拉特后旗巴音满都呼境内,狼山山脉西北的戈壁滩上,巴音满都呼公路口南侧 150 米处和公路北侧 4 公里处的上白垩统牙道黑达组中。根据内蒙水文地质部队在该地实测的剖面列举如下:

~~~未见顶~~~

|                                                                                                                      |       |
|----------------------------------------------------------------------------------------------------------------------|-------|
| 12. 砂砾或砾岩                                                                                                            | 2 米   |
| 11. 砖红色粉砂岩                                                                                                           | 7 米   |
| 10. 含钙质结核灰白色细砂岩                                                                                                      | 0.5 米 |
| 9. 砖红色粉砂岩                                                                                                            | 9 米   |
| 8. 浅黄绿色细砂岩                                                                                                           | 1.5 米 |
| 7. 砖红色粉砂岩                                                                                                            | 7 米   |
| 6. 含钙质砂岩                                                                                                             | 0.5 米 |
| 5. 砖红色粉砂岩,产 <i>Protoceratops</i> sp. (原角龙)                                                                           | 2 米   |
| 4. 含钙质砂岩                                                                                                             | 0.5 米 |
| 3. 砖红色粉砂岩,产 <i>Protoceratops</i> sp. (原角龙)                                                                           | 10 米  |
| 2. 含钙质结核灰白色砂岩                                                                                                        | 0.5 米 |
| 1. 砖红色粉砂岩,产 <i>Protoceratops</i> sp.; 其它类群的恐龙化石;<br><i>Prismatoolithus gebiensis</i> ; 其它类群的成窝恐龙蛋以及低等的<br>爬行类和哺乳类等化石 | 7 米   |

~~~未见底~~~

蒙古上白垩统牙道黑达组及其相关的地层和化石地点出产有著名的安氏原角龙 (*Protoceratops andrewsi*), 恐龙蛋以及含有多瘤齿兽类 (Multituberculates), 真兽类 (Therians) 等的哺乳动物群,其时代被确定为相当于晚白垩世坎帕尼期 (Campanian)

或桑托尼—坎帕尼 (Santonian-Campanian) 之间 (Osmolska, 1980; Savage and Russell, 1983; Jerzykiewicz and Russell, 1991; Jerzykiewicz 等, 1993)。有意思地是北美蒙大拿西部 Teton County 的 *Orodromeus makelai* 蛋化石及其它的恐龙蛋出产于上白垩统 Two Medicine 组的上部, 其时代也被确定为坎帕尼期 (Campanian) (Horner and Weishampel, 1988; Hirsch and Quinn, 1990)。由此看来, 巴音满都呼牙道黑达组的时代相当于坎帕尼期是合适的。

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## FIRST RECORD OF LATE CRETACEOUS HYPSILOPHODONTID EGGS FROM BAYAN MANDUHU, INNER MONGOLIA

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**Key words** Bayan Manduhu, Inner Mongolia; Late Cretaceous; Hypsilophodontid egg

### Summary

A nest of hypsilophodontid eggs was collected from the Djadokhta Formation, Bayan Manduhu, Inner Mongolia Autonomous Region by one of us (Li Rong) in autumn of 1990. This is the first discovery of this type of eggs in China. The first well-documented hypsilophodontid egg was described by Horner and Weishampel in 1988 and by Hirsch and Quinn in 1990 as *Orodromeus makelai* based on the eggs containing identifiable embryonic skeletons found in the Upper Cretaceous (Campanian) Two Medicine Formation of western Montana, North America.

The present paper describes and illustrates these fossil eggshells found in Bayan Manduhu by polarizing light microscopy (PLM) and scanning electron microscopy (SEM).

### Hypsilophodontidae

**Diagnosis** Eggs are elongated ovoid, the eggshell consists of slender interlocking shell units with prisms. Cone layer thin, about 1/7 of eggshell thickness.

The eggs stand vertically and somewhat obliquely in the nest, pointed ends downwards.

#### *Prismatoolithus* gen. nov.

#### *Prismatoolithus gebiensis* sp. nov.

**Holotype** A nearly complete nest with 7 eggs (NMB 4341; Field No. 9002).

**Referred specimen** A completely preserved egg (Field No. 9201)

**Locality and horizon** The entrance of Bayan Manduhu Road, Bayan Manduhu, Urad Houqi, Inner Mongolia Autonomous Region. Upper Cretaceous, Djadokhta Formation.

**Description** The nest contains more or less seven completely preserved eggs which are elongated ovoid. The length and breadth of the eggs are in a ratio of about one to two. The equatorial diameter, located about 40—70mm from the obtuse end of one egg is 50mm, the long diameter of this egg is about 120 mm. These eggs stand vertically and somewhat obliquely in the nest, more pointed at the end embedded in the sediment. In Plate I, 1, the nest with seven eggs is shown upside down.

The eggshell thickness is between 0.7 and 0.9mm. The outer surface of the eggshell is smooth. On some fragments, rough and distinct pits can be observed under the low magnification, and thus it can be assumed that there was more or less extrinsic erosion. The pores are

oval-to-circular opening in the outer surface of the shell. There are no pores at the pointed end. However, the area toward the obtuse end shows an increase in pores. This arrangement may indicate that in the lower, pointed end, once buried part of the egg, gas exchange via the pore canals was not critical.

The mammillae on the inner surface are small. Radial views of the eggshells under PLM and SEM show that the eggshell consists of tall, slender interlocking eggshell units with prisms, revealing a typical avian-like eggshell structure.

The transition between cone layer and columnar layer is gradual, and probably the line of demarcation is quite arbitrary. The cone layer is thinner, representing about only 1/7 of the eggshell thickness. Polarized light revealed cross-shaped interference patterns corresponding to individual crystal columns. The herringbone pattern in the columnar layer seems to be barely visible.

### Comparison and Discussion

On the basis of foregoing results, the diagnosis of our specimens found in Bayan Manduhu is summarized as follows: Eggs elongate, with longitudinal diameter of about 120 mm. The eggs stand vertical, somewhat oblique, on their pointed end in nest. Eggshell about 0.7—0.9 mm thick. The abundance of pores in the area toward the obtuse end. The eggshell consists of slender interlocking shell units with prisms.

By comparing with the dinosaur eggs discovered in the world, it is obvious that specimen from Bayan Manduhu is quite similar to the hypsilophodontid egg found in the Late Cretaceous of western Montana, North America.

Dinosaur eggs are a very special group of vertebrate fossils. The eggshells are, in general, independent of dinosaurian skeletons. They are never structurally connected with the latter, so it is very difficult to assign a certain egg to a certain dinosaur taxon. Recently, the embryonic skeletons, attributable to a new hypsilophodontid *Orodromeus makelai*, were found in a clutch of 19 unhatched eggs from the upper Cretaceous Two Medicine Formation of western Montana, North America (Horner and Weishampel, 1988). On the basis of the identified embryonic remains found with the eggshells, Hirsch and Quinn (1990) established structural morphotype of these eggshells and positively correlated the eggshell morphology with specific dinosaur taxon.

As has indicated, our new specimen seems to be close to the North American *Orodromeus makelai* both in shell morphology and the pattern of arrangement of the eggs within the clutch. However, there are still some differences between them. The outer surface of our specimen is smooth but there is not any longitudinal striations on it. The herringbone pattern in the columnar layer seems to be barely visible. In addition, both eggs occur in different continental respectively. Therefore, our specimen is considered to be a new genus and species of hypsilophodontid eggs. According to Zhao's taxonomical terminology (Zhao, 1975, 1979, 1992), it is assigned the name *Prismatoolithus gebiensis*.

## 图 版 说 明

### 图 版 I

#### 戈壁棱柱形蛋 (*Prismatoolithus gebiensis*)

1. 有 7 枚近乎完整的蛋化石一窝, 倒转面观(编号: NMB 4341; 野外编号: No. 9002)。  
A nearly complete nest with 7 eggs; all eggs in nest are shown upside down (NMB 4341; Field No. 9002).
2. 一枚完整的蛋化石(野外编号: No. 9201)。  
A well-preserved egg (Field No. 9201).
3. 蛋壳外表面观(照片编号: DE 9632)。  
Outer surface of eggshell (Micrograph No. DE 9632 ).

### 图 版 II

#### 戈壁棱柱形蛋 (*Prismatoolithus gebiensis*)

1. 蛋壳外表面观, 示受不同程度侵蚀而形成的微小凹坑(照片编号: DE 7024)。  
Outer surface of eggshell, showing the irregular pits due to erosion (Micrograph No. DE 7024).
2. 蛋壳径切面(照片编号: DE 0216)。  
Radial view of the eggshell (Micrograph No. DE0216).
3. 柱状层高倍放大, 示晶体柱结构排列(照片编号: DE 7033)。  
Enlargement of columnar layer to show columnar structure (Micrograph No. DE 7033).





